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Magnetic black holes and monopoles in a nonminimal Einstein-Yang-Mills theory with a cosmological constant: Exact solutions

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Abstract

© 2016 American Physical Society.Alternative theories of gravity and their solutions are of considerable importance since, at some fundamental level, the world can reveal new features. Indeed, it is suspected that the gravitational field might be nonminimally coupled to the other fields at scales not yet probed, bringing into the forefront nonminimally coupled theories. In this mode, we consider a nonminimal Einstein-Yang-Mills theory with a cosmological constant. Imposing spherical symmetry and staticity for the spacetime and a magnetic Wu-Yang ansatz for the Yang-Mills field, we find expressions for the solutions of the theory. Further imposing constraints on the nonminimal parameters, we find a family of exact solutions of the theory depending on five parameters - two nonminimal parameters, the cosmological constant, the magnetic charge, and the mass. These solutions represent magnetic monopoles and black holes in magnetic monopoles with de Sitter, Minkowskian, and anti-de Sitter asymptotics, depending on the sign and value of the cosmological constant Λ. We classify completely the family of solutions with respect to the number and the type of horizons and show that the spacetime solutions can have, at most, four horizons. For particular sets of the parameters, these horizons can become double, triple, and quadruple. For instance, for a positive cosmological constant Λ, there is a critical Λc for which the solution admits a quadruple horizon, evocative of the Λc that appears for a given energy density in both the Einstein static and Eddington-Lemaître dynamical universes. As an example of our classification, we analyze solutions in the Drummond-Hathrell nonminimal theory that describe nonminimal black holes. Another application is with a set of regular black holes previously treated.

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